Silvical Characteristics of Pitch Pine

(*Pinus rigida*)

by S. Little

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Preface

MUCH of the silvical information on our forest trees is widely scattered and sometimes difficult to find. To make this material more readily available, the Forest Service is assembling information on the silvical characteristics of all the important native forest tree species of the United States. It is expected that this information will be published as a comprehensive silvics manual.

This report presents the silvical characteristics of one species. It contains the essential information that will appear in the general manual but has been written with particular reference to the species in the Northeast. Similar reports on other species are being prepared by this Experiment Station, and by several of the other regional forest experiment stations.

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About the Author ...

SILAS LITTLE *was graduated from Massachusetts State College, and later obtained Master's and Ph.D. degrees in forestry from Yale University. A member of the U.S. Forest Service since 1936, he has worked chiefly on forest-management research in southern New Jersey and eastern Maryland. At present he is in charge of the New Lisbon (N. J.) Research Center of the Northeastern Forest Experiment Station.*

The Pitch Pine

PITCH PINE *(Pinus rigida* Mill.*)* grows over a wide geographical range--from central Maine to New York and extreme southeastern Ontario, south to Virginia and southern Ohio, and in the mountains to eastern Tennessee, northern Georgia, and western South Carolina *(10)*. Because it grows mostly on the poorer soils, its distribution is spotty.

In the Northeast, pitch pine is most common on the sandy soils of Cape Cod, Long Island, and southeastern New Jersey, and in some sections of sandy or shallow soils in Pennsylvania. Forest-survey data show that pitch pine types cover 24,500 acres in New Hampshire *(34)*, 211,000 acres in Massachusetts *(6)*, 3,000 acres in Rhode Island *(7)*, possibly 110,000 acres in New York *(36)*, more than 300,000 acres in Pennsylvania *(37)*, and more than 700,000 acres in New Jersey *(46)*. Other Northeastern States contain smaller acreages in this species, although about 463,000 acres in Maryland and 855,000 acres in West Virginia are in the pitch pine-Virginia pine--hardwood types *(35, 48)*. However, in these two states the Virginia pine *(Pinus virginiana)* component greatly exceeds pitch pine in most stands.

Habitat Conditions

CLIMATIC

Climate in the range of pitch pine varies greatly; but, according to Thornthwaite's classification *(43)*, it is all humid. Average annual precipitation is mostly between 37 and 56 inches, and on the whole it is well distributed throughout the year. Length of the frost-free season varies from 112 to 190 days, and temperatures vary from winter lows of -40°F. in the northern part of the range to summer highs of over 100°F. in most sections *(44)*.

SOILS

Pitch pine is usually restricted to the less fertile soils--those of shallow depth, or of sandy or gravelly texture. Many of the northern stands occur on sandy outwash plains of glacial origin. The species also occupies sandy and gravelly soils of alluvial or marine origin. In the highlands of northern New Jersey, southern New York, Pennsylvania, and south through the mountains, it is most common on steep slopes, ridges, and plateaus where the soils are shallow.

For the most part, pitch pine grows on acid podzol or podzolic soils. These fall chiefly into three of the great soil groups--podzol, brown podzolic, and gray-brown podzolic soils. In one study of pitch pine in southern New Jersey, the pH of the A and B horizons varied between 3.5 and 5.1 *(28)*; in a study in northern New Jersey, between 4 and 4.5 *(33)*.

Pitch pine grows on a wide range of moisture conditions. In southern New Jersey it occurs on excessively drained, imperfectly drained, and poorly drained sands and gravels, as well as on peat soils in the white-cedar swamps.

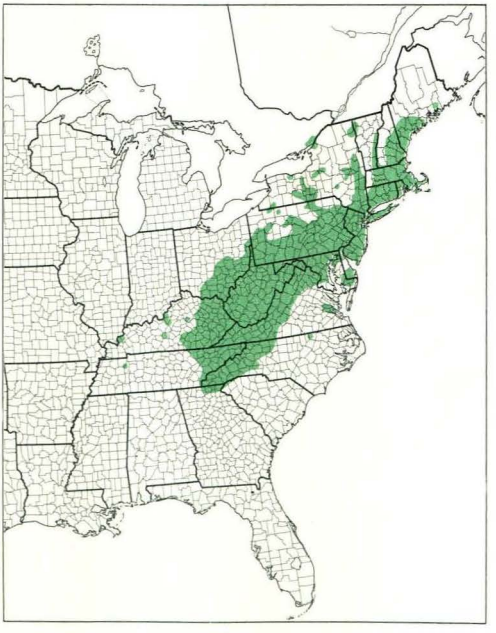

Figure 1.--*The natural range of pitch pine.*

DISTRIBUTION MAP BY
ELBERT L. LITTLE, JR.
U.S. FOREST SERVICE

Even in the hilly regions it occurs both on well or excessively drained slopes and in the swamps *(9)*.

PHYSIOGRAPHIC

Pitch pine grows from sea level to the top of some of the highest mountains in the East, of course extending to higher elevations in the South. In New England it is most common in the coastal districts and in river valleys. In New York it is not common above 2,000 feet, but in Pennsylvania it grows at all elevations up to the highest point in the state (3,213 feet) *(9)*. In the Great Smoky Mountains and vicinity pitch pine is found at elevations between 1,400 and 4,500 feet *(47)*. In hilly sections, pitch pine often occupies the warmer and drier sites, those facing south or west.

BIOTIC

Deer *(Odocoileus virginianus)* browse on fresh sprouts and seedlings of pitch pine, particularly on those less than 20 inches tall *(21, 22)*. According to one report *(9)*, deer browse this tree in preference to other Pennsylvania conifers. Cottontail rabbits (chiefly *Sylvilagus floridanus)* also feed on pitch pine seedlings, as do meadow mice *(Microtus pennsylvanicus) (9)*.

Pitch pine seed undoubtedly is eaten by many species of birds and rodents; however, there apparently are no specific data on the more important consumers. From personal observations and inferences from the literature *(3, 31, 38)*, chickadees *(Penthestes atricapillus)*, red crossbills *(Loxia curvirostra pusilla)*, pine siskins *(Spinus pinus)*, juncos *(Junco hyemalis)*, and quail *(Colinus virginianus)* appear to be among the more important birds. Mice, particularly the white-footed mouse *(Peromyscus leucopus)*, feed heavily on the seeds of various pine species when available, and squirrels shred pine cones for the seed. Eastern gray squirrels *(Sciurus carolinensis)*, red squirrels *(Tamiasciurus hudsonicus)*, eastern chipmunks *(Tamias striatus)*, and flying squirrels *(Glaucomys volans)* all probably eat appreciable quantities of pitch pine seed.

Pitch pine is a minor component or associate in twelve forest cover types of eastern North America, but in only one type (pitch pine, No. 45) is it pure or predominant *(39)*. Because of the wide range in latitude and site, many

tree species are found growing with pitch pine. They include red pine *(Pinus resinosa)*, eastern white pine *(P. strobus)*, shortleaf pine *(P. echinata)*, Virginia pine *(P. virginiana)*, table-mountain pine *(P. pungens)*, gray birch *(Betula populifolia)*, white oak *(Quercus alba)*, black oak *(Q. velutina)*, chestnut oak *(Q. prinus)*, post oak *(Q. stellata)*, blackjack oak *(Q. marilandica)*, scarlet oak *(Q. coccinea)*, northern and southern red oaks *(Q. rubra* and *Q. falcata)*, hickories *(Carya* spp.), blackgum *(Nyssa sylvatica)*, red maple *(Acer rubrum)*, eastern hemlock *(Tsuga canadensis)*, and Atlantic white-cedar *(Chamaecyparis thyoides)*.

Usually the most common shrubs growing with pitch pine on upland sites are lowbush blueberries *(Vaccinium pallidum* and *V. angustifolium)* and huckleberries *(Gaylussacia baccata* and *G. frondosa)*. In some stands they include bear oak *(Quercus ilicifolia)*, dwarf chinkapin oak *(Q. prinoides)*, and mountain-laurel *(Kalmia latifolia)*.

Lowland sites where pitch pine predominates have a wide variety of shrubs. Common ones there include sheep-laurel *(Kalmia angustifolia)*, leatherleaf *(Chamaedaphne calyculata)*, staggerbush *(Lyonia mariana)*, inkberry *(Ilex glabra)*, dangleberry *(Gaylussacia frondosa)*, highbush blueberry *(Vaccinium corymbosum)*, and swamp azalea *(Rhododendron viscosum) (20)*.

Several fungi attack pitch pine, but usually none causes serious or extensive damage. Among these are several gall rusts (especially *Cronartium cerebrum* and *C. fusiforme*), which cause stem swellings of different shapes; sweetfern blister rust *(C. comptoniae)*; needle casts or needle blights *(Lophodermium pinastri, Hypoderma lethale,* etc.); pine needle rusts *(Coleosporium solidaginis, C. campanulae, C. helianthi,* etc.); and heart rots, chiefly by *Fomes pini (2)*. Heart rot does not become important until after stands are 75 years old, or older than they would be grown under management.

Many insects attack pitch pine. The most important are the tip moths *(Rhyacionia frustrana* and *R. rigidana)*, the pitch pine looper *(Lambdina athasaria pellucidaria)*, the sawflies (chiefly *Neodiprion lecontei, N. dyari*[1], and *N. pini-rigidae)*, the southern pine beetle *(Dendroctonus frontalis)*, the pine webworm *(Tetralopha robustella)*, and the

[1]Now considered to be *Neodiprion pratti paradoxicus*.

pine needle miner *(Exoteleia pinifoliella) (4)*. John H. Lambert, Massachusetts Department of Natural Resources, states (in correspondence) that loopers periodically cause extensive damage to pitch pine in Massachusetts; in 1954 they defoliated pines on more than 50,000 acres of Cape Cod. However, the author's observations indicate that serious or extensive damage from insects is usually limited to plantations or to stands injured by fire or drought.

Life History

SEEDING HABITS

Flowering and fruiting.--In southern New Jersey the staminate flowers of pitch pine become visible during the last half of April; pistillate flowers, about May 8. Pollen-shedding occurs usually during the third week in May *(12)*. Cones reach full size--1½ to 3 inches long--and mature at the end of the second summer.

Seed production.--Vigorous open-grown basal sprouts start bearing mature cones when only 3 years old. Occasionally some bole sprouts bear cones at a similar age (fig. 2).

Very rarely an exceptionally vigorous open-grown seedling will bear one or more mature cones when only 4 years old. Andresen *(1)* reports that, of 400 planted 2-year-old seedlings, two bore a total of three mature cones at the end of their second growing season in the plantation. However, mature cones are not usually borne on open-grown seedlings until they are 8 to 12 years old. Shade-grown stems begin producing cones at a still later date.

Cone production varies greatly with tree size and crown class. Overtopped stems produce few or no cones; intermediate ones, a few; while usually only the open-grown or dominant trees are prolific producers. Of course, average production of cones increases markedly with tree size.

Although pitch pine is reported to bear good crops of cones at approximately 3-year intervals *(9)*, production may be irregular. In southern New Jersey good to excellent crops have occurred at intervals of 4 to 9 years. Occasionally poor crops are borne in two successive years, although usually a poor crop is followed by fair to excellent crops for 1 to 3 years.

Figure 2.--*Even after all its foliage has been killed by a fire, pitch pine will often "green up" by putting forth bole sprouts. The bole sprouts on this tree bore mature cones 4 years after a wildfire.*

Seed dissemination.--Seed dissemination is variable, depending on the length of time that cones remain closed after maturity. There are two extremes in this respect, with many gradations between. The extremes of cone behavior are represented by: (1) trees on which the cones, like those of most conifers, open soon after maturity; and (2) trees on which the cones remain closed for many years, often until the heat of a fire opens them, or until the trees have been cut. Trees of the latter type are characteristic of the areas having the worst wildfire history.

Although cone behavior is believed to be an inherited characteristic, in southern New Jersey, at least, groups of trees with different cone behavior are not widely separated geographically. Probably their closeness accounts for the many gradations between the two extremes.

Among trees on which the cones open soon after maturing, seed dispersal starts about November 1 and ends in April in southern New Jersey *(12)*. From general observations, the pattern of dispersal seems similar to the pattern for the shortleaf pine; in one study this species dropped 69 percent of its seed the first month, and 90 percent during the first two months *(11)*. In New Jersey, probably about 90 percent of the seeds dispersed from a pitch pine source fall on the east side. This is inferred from studies of Atlantic white-cedar in the same region, where 80 to 85 percent of the seeds were found to fall on the east side because the prevailing fair-weather winds are from the west *(14)*. Since pitch pine cones close in wet weather even quicker than those of white-cedar, an even larger proportion of the pitch pine seeds would be dispersed during fair-weather westerly winds.

On trees exhibiting cone behavior between the two extremes, the cones open erratically within a few years after maturing. Apparently there is no fixed pattern of when or what cones open, or in what numbers.

Practically all dissemination is by wind. Rodents and birds distribute seed to a minor extent. By their "hoarding" activities, rodents are responsible for some of the dense clumps of seedlings that occasionally may be seen.

Although equipped with large wings, pitch pine seeds usually are not carried very far by wind. The widest dispersal occurs from isolated trees or from the edges of stands. Even on the leeward of one stand, natural reproduction in an abandoned field was all within 300 feet *(9)*.

VEGETATIVE REPRODUCTION

Pitch pine is outstanding among eastern conifers in its ability to survive injury (fig. 3). All its foliage may be killed by the heat of a fire, and still the crown will "green up". If 2 or 3 feet of the terminal shoot is killed, a new one often develops. Or if the entire stem is killed, sprouts frequently start at the base *(15, 28)*. Deer may clip a seedling back to an inch or two above the ground, and still it may live *(21)*.

Dormant buds, capable of active growth when properly stimulated, are the key to this recovery. Thick bark, conferring a relatively high degree of protection to the dormant

Figure 3.--*Pitch pine is outstanding for its ability to survive fire injury. Fire consumed the foliage and killed the leaders on the pitch pines shown here, but three of them have put forth bole sprouts.*

The tree in the center suffered the least damage, now has the best crown, and may develop a new leader. The tree on the right probably will not form a new leader; so its crown may develop a flat top. Though both of these trees will probably live, neither will ever have a long clear bole or a well-formed crown.

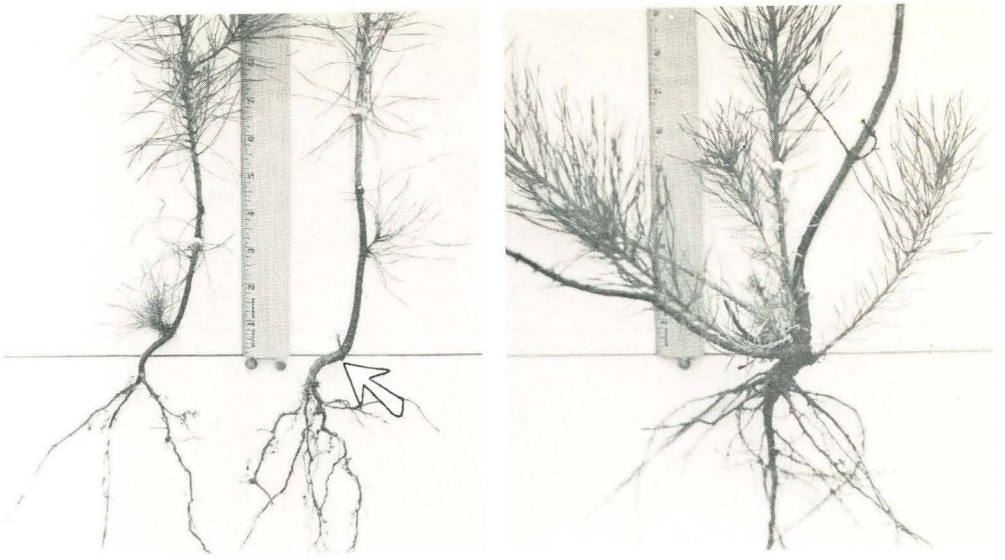

Figure 4.--*Dormant buds help pitch pine recover from fire damage. Of the two 4-year-old seedlings shown on the left, one has a well-developed basal crook. Note the bud (arrow) on the lower side of the stem opposite the short shoot. This bud was below the forest floor.*

Such buds were the source of the first-year sprouts shown in the right-hand photo. These sprouts are the second set of sprouts produced, both the original seedling stem and the first generation of sprouts having been killed by fires. Black line marks soil surface.

buds and to the cambium, is an important contributing factor. Both pitch and shortleaf pines have these buds along the bole to an age of 60 years or more, but at such ages the buds at the base retain the potential for growth only in pitch pine. Even in seedlings (both species) that have not yet developed much thickness of bark, the lowermost buds may be protected by characteristic basal crooks in the stem that bring them into or against mineral soil on upland sites (fig. 4). Such buds often survive fires and produce new shoots *(26, 40, 41)*.

Some pitch pine seedlings, of course, cannot sprout after fires. These include: (1) the occasional seedlings that never develop a basal crook, and around which insufficient soil accumulates to protect the buds; (2) seedlings that started on Sphagnum or on the deep humus layer of poor-

Figure 5.--*Repeated wildfires have created this sprout stand of pitch pine and scrub oaks. The slow-growing deformed pitch pine sprouts developed on old stools, many of which were probably 50 to 80 years old when this crop of sprouts started.*

ly drained sites, and around which a fire burns deeper than the surface where they became established; and (3) seedlings too young to have well-developed basal crooks. Though some open-grown seedlings may develop such crooks in their first year, shade-grown seedlings may take 9 or 10 years *(26)*.

While pitch pine's sprouting ability is an asset in enabling trees to survive fire or other injuries, it is also a liability from the commercial point of view (figs. 3 and 5). Apparently the form and growth rate of sprouts decrease markedly with increased age of the root crown after crown age reaches about 20 years. In places where wildfires have occurred at frequent intervals, stands are often composed largely of slow-growing sprouts from old stools (fig. 5). In many other stands the stems have been deformed by past fires in one or more of these manifestations: (1) boles with many small branches that have developed along them to replace killed crowns, (2) boles with one or more crooks or forks where terminal shoots have been killed, or (3) trees with flat tops where no leader has developed after the last one was killed.

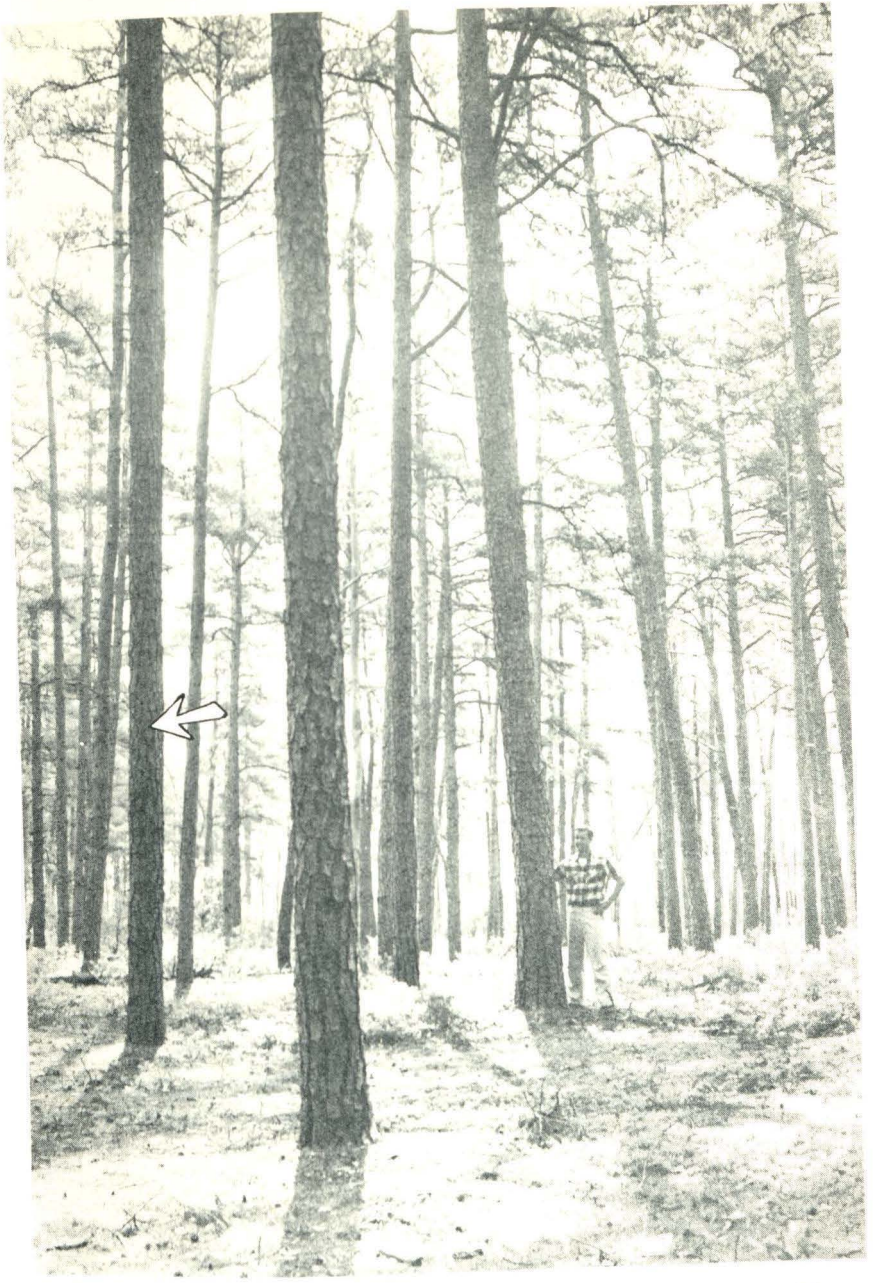

Figure 6.--*Pitch pine can develop good form. In this stand of shortleaf and pitch pines in southern New Jersey, notice the form of the pitch pine (arrow). It is just as straight as the shortleaf pines, and it has fewer branches along its bole than the shortleaf pine by which the man is standing.*

Such recovery is typical of pitch pine, but at the same time it creates an erroneous impression that this species never has good form. Actually, uninjured stems of seedling or seedling-sprout origin develop a form similar to that of shortleaf pine (fig. 6).

SEEDLING DEVELOPMENT

Establishment.--The average germinative capacity of pitch pine seed, according to the Woody-Plant Seed Manual *(45)*, is 77 percent, with a recorded range of 19 to 99 percent.

Although one report stated that seeds from trees less than 8 years old are usually sterile *(9)*, the author's experience does not support that generalization. A cutting test on 200 seeds from 3-year-old sprouts showed 94 percent to be sound. And Andresen *(1)* reports that 52 percent of the seed in two cones from 4-year-old seedlings germinated within 9 days.

Some pitch pine seeds may remain viable in the forest floor for 1 year, but there is no evidence that they can lie over for much longer periods. In one instance, after a July wildfire had opened many closed cones, most of the seed germinated the following spring, though a few lay dormant until August, then germinated after rains had broken a severe dry period. In another instance involving 2,400 seed spots sown to pitch pine in late March 1955, delayed germination in the spring of 1956 provided as many as 1.4 seedlings per spot in some treatments *(16)*.

From the small amount of reserve food in the seed, pitch pine seedlings develop a short taproot and stem--each only about an inch long. Hence, for successful establishment of seedlings there must be adequate moisture near the surface to sustain growth until a sufficiently long taproot can develop.

Consequently, thick litters are quite unsuitable as seedbeds, even on poorly drained sites. In one study hardly any new seedlings were found in July on the thick litters of unburned sites; while on similar areas, treated with a severe September fire before seedfall, 6,700 to 22,800 new seedlings per acre were tallied on very poorly to imperfectly drained sites, and 900 per acre on upland sites *(20)*. The best seedbed for natural reproduction on upland sites is

either mineral soil or a film-like layer of forest floor *(19)*. Direct-seeding studies have shown that, even on severely burned sites, 2 to 6 times as many seedlings started where the seeds were lightly covered as where the seeds were not covered *(16)*.

Droughts can, and do, kill many pitch pine seedlings, but those less than 2 years old are most susceptible. The 1957 summer drought killed 81 percent of the seedlings from a 1956 direct seeding in certain plots, while on comparable sites most of the seedlings that had started in 1955 survived *(16)*.

Early growth.--At the end of the first year, shaded seedlings on upland sites usually have a height of about 1 inch, and a taproot 3 to 4 inches long with few laterals. In contrast, vigorous open-grown 1-year seedlings on upland sites may have stems 2 to 4 inches long (maximum 5 inches), with correspondingly greater root systems. On the moister, poorly drained sites, open-grown 1-year stems will usually be 3 to 6 inches long (maximum 8 inches).

In the Pennsylvania nurseries of 30 years ago, pitch pine seedlings averaged 3 inches in height at the end of the first year, 7 inches at the end of the second *(9)*. Under modern fertilizer practices, pitch pine seedlings in New Jersey nurseries are 4 to 5 inches tall at the end of the first year, 10 to 12 inches at the end of the second year.[2]

Pitch pine seedlings tend to grow rather slowly for the first 3 to 5 years, and then to grow more rapidly. Some planted stands in Pennsylvania maintained an average height growth of 14 to 19 inches between 6 and 17 years in age *(9)*. After a seed-tree cutting in a New Jersey stand, the average height growth of dominant seedlings among the natural pitch pine reproduction was 1.5 and 2.2 feet respectively during the third and fourth growing seasons after the cutting *(24)*.

Deer browsing and hardwood competition both reduce pine growth rates. In one study, pine seedlings uninjured by deer grew 2 to 4 feet more during a 5-year period than those that had their leaders browsed two or more times *(21)*. In another study, cutting back hardwood sprouts twice resulted, after 6 years, in a 4-foot increase in the height growth of the largest pines *(19)*. In competing pine and sprout hard-

[2]According to L.C. Smack, New Jersey Department of Conservation and Economic Development.

wood reproduction, browsing of the pines handicaps them, sometimes enough to increase the proportion of hardwoods in the next crop *(23)*.

SAPLING STAGE TO MATURITY

Root development.--Root development of the older pitch pines varies with the site. On sandy, well-drained soils, vertical roots of trees 4 inches and larger in diameter (b.h.) may reach depths of 8 to 9 feet, but on heavier or wetter soils the root systems are more shallow. However, even in saturated soils where water tables are less than a foot below the surface, pitch pine roots may reach depths of 3 to 5 feet in sandy sites. There, and in the swamps, pitch pine roots live and grow below the water table, with mycorrhizae occurring on some of the submerged roots *(30)*.

Possibly because pitch pine roots so deeply, it is relatively wind-firm. In Maryland, Virginia pine proved much more susceptible to windthrow than pitch pine *(5)*.

Growth and yield.--Pitch pine reaches a maximum age of 200 years, a maximum diameter of 30 inches, and a maximum height of 100 feet in Pennsylvania. In stands it is seldom more than 80 feet tall or 2 feet in diameter *(9)*.

On the better sites in Pennsylvania, pitch pine maintains an average height growth of a foot or more annually until the trees are 50 to 60 years old. The rate of height growth then starts to decline, and the trees add little to their height after they are 90 to 100 years old. On the best sites, diameter growth is most rapid (1 inch in 5 years) at 20 years of age, falling to an inch in 8 years at 90 years *(9)*.

Total volume in cubic feet is at its maximum in Pennsylvania at 90 years, when fully stocked even-aged stands yield 15,000 to 25,000 board-feet per acre. However, mean annual growth in cubic feet reaches its maximum at about 30 years--43 to 83 cubic feet, depending on the site *(9)*.

Understocked sprout stands subjected to periodic wildfires of course yield much less. Even some of the better stands of this type produce only 6 to 8 cords in 60 years.

In closed stands of seedling origin undamaged by fire, pitch pine self-prunes about as well as shortleaf pine (fig. 6), but in understocked stands it tends to produce somewhat

larger and more persistent branches than shortleaf. Open-grown trees typically develop large spreading branches, which contribute to the rough appearance that many people associate with the species. However, the main reason why pitch pine with long, clear boles is seldom seen is not primarily because of its branching characteristics, but because, in the areas where it commonly grows, it seldom has opportunity to develop its crowns free from fire damage in closed stands. Typical pitch pine areas have been burned repeatedly, most of the stands are understocked, most of the trees have suffered fire injury, and in consequence trees have either retained branches or have developed them from dormant buds along the boles.

Even without the stimulus of fire, pitch pines suddenly released by heavy cutting in a stand may develop branches along the bole in much the same way as do many hardwoods. Pruning of living branches also may stimulate the development of new branches from buds or short shoots, as McLintock *(29)* has reported.

Reaction to competition.--Pitch pine is intolerant of shade. On swamp sites, it is less tolerant than Atlantic white-cedar, and on poorly drained or upland sites it is less tolerant than its common hardwood associates--blackgum, red maple, various oaks, and hickories *(9, 13, 14, 17)*.

In view of its relatively low tolerance and its requirement of mineral soil for germination, pitch pine can be best maintained in stands by even-aged management, with seedbed preparation and control of competing hardwoods.

Specific measures vary with site. On poorly drained sites in southern New Jersey, a hot summer fire at the end of the rotation is effective in reducing competing vegetation and in preparing seedbeds, but such a fire is so damaging that it should either follow a seed-tree cutting or shortly precede a clear-cutting *(20)*. On well-drained sites periodic winter burning under stands is usually more effective than a single hot fire in obtaining the establishment of sufficient reproduction *(20)*. Such periodic burns in stands older than 15 years aid both in controlling competing vegetation and in protection from wildfires *(15, 17, 32)*.

Periodic burns, supplemented in dense stands by shelterwood cuttings, also favor the establishment of advance pine reproduction *(18)*. Such reproduction is highly desirable for insuring prompt restocking of cut-over areas and rapid growth of the pine seedlings. An alternative or sup-

plement to this advance growth is reproduction starting after seed-tree cuttings, but the latter is less reliable, being more subject to drought and animal damage.

On all sites cleanings or poisoning of hardwoods usually are desirable for increasing the stocking of pine *(15, 20)*. Practical measures for managing pitch pine in other sections have not been determined.

Fire has been largely responsible for maintaining the pitch pine type, but also has been responsible for the sprout origin, comparatively slow growth, and poor form that often characterize this species. One severe fire may eliminate non-sprouting associates, such as white pine; repeated severe fires may eliminate such species as shortleaf pine and white oak, which do not produce seed at so young an age as pitch pine and bear oak *(9, 13, 17, 24, 28)*.

Deer, rabbits, wind, snow, ice, and salt spray have also at times damaged pitch pine stands. Damage by deer and rabbits is limited mostly to small seedlings or sprouts, while the most common wind damage is breakage of defective large trees. However, severe storms, such as hurricanes, may also cause many windfalls in the oldest natural stands and in plantations more than 20 years old (especially if the planted trees are infected with root rots). Heavy wet snows or ice occasionally break leaders or branches in trees of all sizes, but open-grown stems with large branches, particularly those 8 to 15 feet tall, seem most susceptible. While pitch pine foliage is more resistant to salt-spray damage than that of associated species *(8, 14)*, hurricanes or gales can deposit sufficient spray to injure or kill its foliage over extensive coastal areas. However, the chief result is a reduction in growth, since hardly any of the affected pitch pines die.

Special Features

The resinous nature of pitch pine wood is responsible for the accepted common name of the species and for several local names such as torch pine, rich pine, and fat pine. The resinous wood, particularly in old knots, served as torches to light early cabins or the way of travelers *(9)*.

During the colonial period and again during the Civil War, pitch pine served as a source of naval stores. In southern New England, New Jersey, Pennsylvania, and probably Long Island, too, pitch, tar, and rosin were early exports from the Colonies. At certain times and localities, as from Gloucester County, New Jersey, about 1695 *(42)*, these naval stores formed the principal export. And large forests of pitch pine were used in supplying the local shipbuilders and for export to Great Britain *(9)*.

Races and Hybrids

There is no definite information on races of pitch pine. Geographical races would not be surprising in view of its latitudinal range. The two extremes in cone-opening characteristics appear to be inherited, and trees with these should perhaps be considered as separate races or ecotypes.

When pitch and shortleaf pines grow together, natural crossing may occasionally occur. At least the author has seen individual trees with intermediate characteristics in southern New Jersey, and similar trees have been reported in southern Pennsylvania *(9)*.

At Placerville, the California Forest and Range Experiment Station has crossed pitch and shortleaf, and pitch and loblolly *(Pinus taeda)*. In field trials in Illinois, Maryland, and New Jersey, only the pitch x loblolly hybrids have shown any promise *(25, 27)*.

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